Plastics Recycling Primer

Prepared for the Maine State Planning Office

By

MOORE
RECYCLING ASSOCIATES INC.
Recycling Implementation Specialists

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Introduction

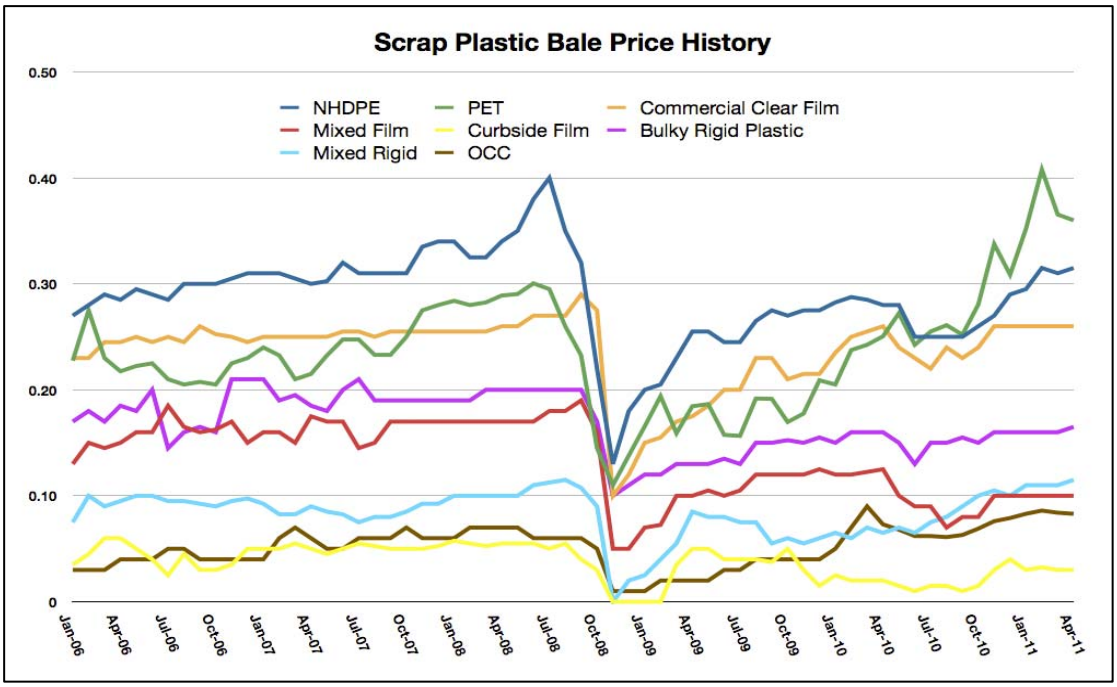
Since their introduction into the marketplace, plastics have become an increasingly prominent material used in the manufacture of durable and non-durable goods and containers and other packaging within industrial, commercial and consumer applications. The chemical and physical properties of individual plastic resin types—strength, flexibility, durability, light-weight and moldable properties—make them ideal for a variety of applications ranging from automobile parts to computer housings to single use plastic bottles and bags. Because they're durable, lightweight, and versatile, plastics help reduce waste and consume less energy. In addition to requiring less material to make a package, lighter packaging means lighter loads or fewer trucks and railcars needed to ship the same amount of product, helping to reduce transportation energy usage, decrease emissions and lower shipping costs.

Along with the increase in plastic used to manufacture goods and packaging, comes the increase in plastics in the waste stream. According to the 2009 EPA Waste Characterization study, plastics comprised less than 1% of the municipal solid waste stream in 1960 whereas now

plastics comprise 12.3% of the municipal solid waste stream, on a weight basis, not volume. Some of that increase can be attributed to the switch from paper and glass to plastic for many container and packaging applications. For example, plastic bottles have replaced glass bottles and jars and metal container for beverages and other food packaging applications; plastic film has replaced corrugated cardboard cartons for shipping palletized goods and plastic bags have replaced paper bags in many venues.

The material use shift is not only happening in the US but in countries around the world. Goods are produced and shipped worldwide. As developing countries' economies grow, so does their consumption of durable and non-durable goods, all of which are utilizing the ever-changing array of plastic resins. These countries are also manufacturers of products that are shipped worldwide and their demand for raw material, including plastic resins, for manufacturing is increasing. This raw material demand also includes recycled materials as it can often be procured at a lower cost than virgin materials. Plastics and paper are key examples of recycled materials exported to foreign countries at increasing rates. We will discuss some of the nuances of exporting plastics later in this report.

There are over 10,000 defined plastic resins, many of which have been specifically designed for a particular application. Although these varied plastic resins have replaced paper, metal and glass in many durable and non-durable applications, this report will focus on those plastics most readily found in residential municipal solid waste steam; plastics which can be or already are readily accepted for recycling; and plastics for which there is a current or expanding demand. As can be seen in the chart below, these materials have significant scrap value; most are more valuable on a weight basis, than corrugated cardboard (OCC). OCC has been used as the comparison material because it is usually the highest priced fiber recyclable material. Values in the chart are price per pound. Common residential plastic represented in this chart are NHDPE-natural high-density polyethylene bottles; PET-polyethylene terephthalate bottles; curbside film- mainly grocery bags; mixed rigids - any plastic container not a NHDPE or PET bottle; and OCC-old corrugated cartons.



Plastic Packaging Resins

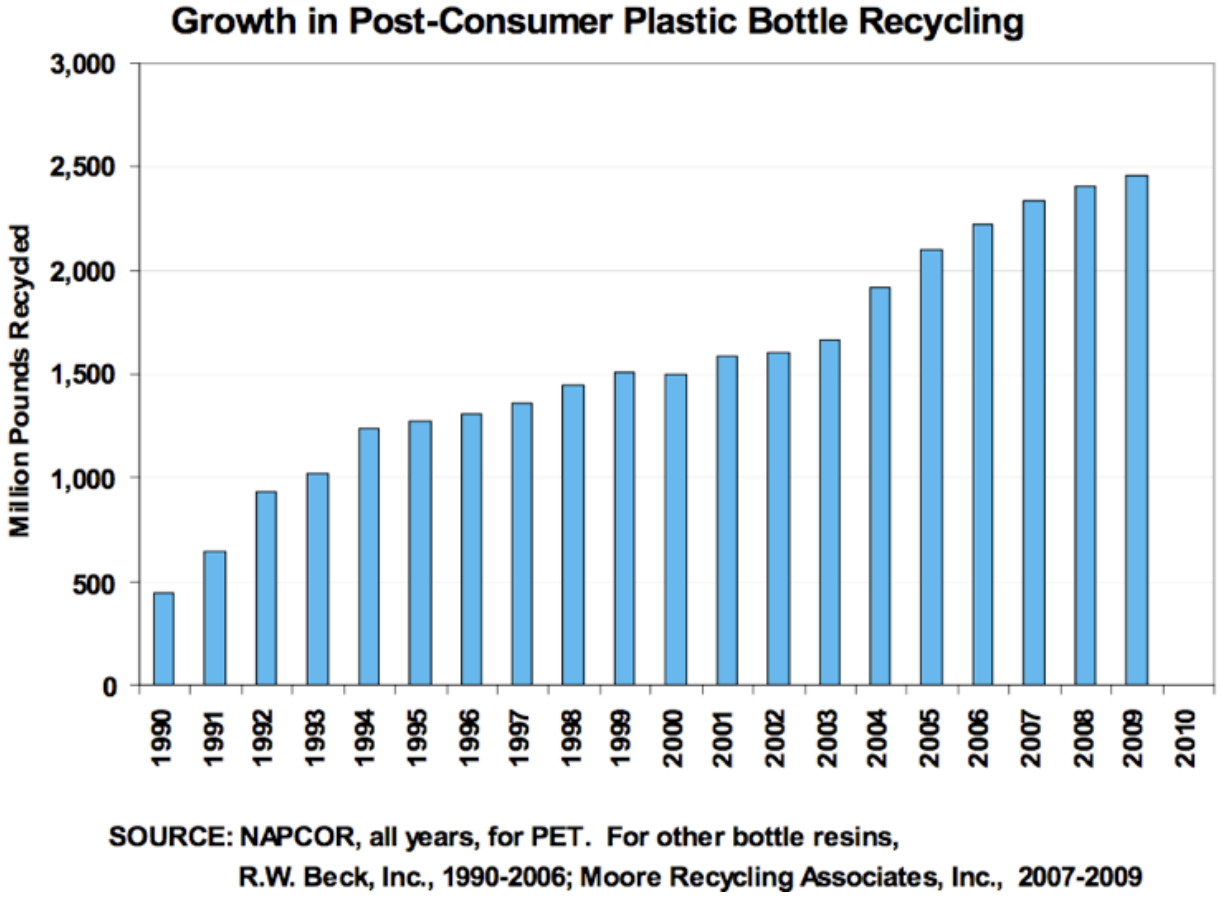
Plastic resins used to package consumer goods, used as containers and other packaging applications are defined in the "Plastic Packaging Resins" chart in Appendix A. The chart lists the primary packaging resins found in the residential solid waste stream and their corresponding numbers, a brief description, their properties, initial product applications and recycled resin applications. Throughout this report we will refer to the plastics discussed by the acronyms described in this chart.

1-PET: Polyethylene Terephthalate
2-HDPE: High Density Polyethylene
3-PVC: Polyvinyl Chloride
4-LDPE: Low Density Polyethylene
5-PP: Polypropylene
6-PS: Polystyrene
7-Other: Any other material than 1-6 or combination there-of

Post-Consumer Plastic Bottle Recycling

For many years, post-consumer plastics recycling focused on PET and HDPE bottles (containers with a neck smaller than the base). In the late 1970's and into the 1980's these bottles became more prevalent in the municipal waste stream as carbonated beverages and milk moved from glass to plastic packaging. Fast forward, over the next 10 years, bottle redemption laws, a focus on environmental and recycling awareness, available funding for entrepreneurial ventures and demand for less expensive plastic resin raw material fueled the beginnings of the plastic recycling industry infrastructure.

While PET and HDPE recycling rates have moved up and down over the past 4 decades (achieving rapid growth in the beginning of the movement, slowing down or decreasing at several points and currently achieving steady but slow growth) the amount of plastic bottles used and collected has climbed steadily.



SOURCE: NAPCOR, all years, for PET. For other bottle resins, R.W. Beck, Inc., 1990-2006; Moore Recycling Associates, Inc., 2007-2009

The 2009 United States National Post-Consumer Plastics bottle Recycling Report states that the plastic bottle-recycling rate for 2009 was 27.8 %, up slightly from 2008 and, as seen in the chart above, the total tonnage of plastic bottles recycled in 2009 reached its highest level at 2,456 million pounds. This chart represents HDPE, PET, PVC, LDPE, PP and "other resin" bottles.

This is good news for the plastics recycling industry, showing steady growth. However, domestic reclaimers report they continue to operate below capacity further supporting the need to recover more plastic bottles. Educating consumers and recycling professionals about the demand for and value of recycled plastic HDPE and PET can support increased recovery of plastic bottles. The lack of access to recycling opportunities to recover plastic bottles used and discarded away from home continues to be a significant barrier to increased plastic bottle recycling. Although some efforts have been made to address recycling away from home, it is clear that more work needs to be done.

Although plastic bottles were recycled at an all time high in 2009, the quality of plastic bottle bales fell in 2009, resulting in an overall reduced yield of 2.5% bottle material being available for recycling between 2008 and 2009. What this means is that the reclaimer must purchase more bales to achieve the same operational capacity. Single stream recycling, the increasing desire to collect more than bottles, and the ability to market lower-quality bales to the export market are all contributing factors to the general decline in bale quality.

The 2009 United States Post-Consumer Plastics Bottle Recycling Report can be found at http://plastics.americanchemistry.com/09-Post-Consumer-Plastics-Bottle-Recycling-Rpt. The report gives detailed information about bottle resin sales, US per capita consumption of plastic bottles, end use markets for recycled plastics, reclamation industry data as well as recycling data for all plastic bottles.

Recycling More Plastics

In the 2009 EPA Waste Characterization Report, (Table 1 in 'Facts and Figures Fact Sheet, shown below) it shows that in terms of 'Recovery as Percent of Generation' for plastics is 7.1%, the second to lowest recovery rate for the identified materials, with only food and related organics lower in terms of recovery rate. This comparative observation is important in showcasing the huge opportunity to increase/improve recovery and recycling efforts in the world of plastics.

Material	Weight Generated	Weight Recovered	Recovery as Percent of Generation
Paper and paperboard	68.43	42.50	62.1%
Glass	11.78	3.00	25.5%
Metals			
Steel	15.62	5.23	33.5%
Aluminum	3.40	0.69	20.3%
Other nonferrous metals†	1.89	1.30	68.8%
Total metals	**20.91**	**7.22**	**34.5%**
Plastics	29.83	2.12	7.1%
Rubber and leather	7.49	1.07	14.3%
Textiles	12.73	1.90	14.9%
Wood	15.84	2.23	14.1%
Other materials	4.64	1.23	26.5%
Total materials in products	**171.65**	**61.27**	**35.7%**
Other wastes			
Food, other‡	34.29	0.85	2.5%
Yard trimmings	33.20	19.90	59.9%
Miscellaneous inorganic wastes	3.82	Negligible	Negligible
Total other wastes	**71.31**	**20.75**	**29.1%**
Total municipal solid waste	**242.96**	**82.02**	**33.8%**

With the advent of single stream recycling has come the collection of additional plastics other than PET and HDPE bottles. Many single stream

collection programs allow, in addition to plastic bottles, the inclusion of all plastic containers and some go so far as to allow even more plastics, such as 5 gallon buckets, toys, crates, baskets and other bulky plastics. All of this material being received at material recycling facilities (MRFs) has created confusion about the composition and terminology for mixed resin bales.

MRF operators have been pulling out HDPE buckets and other bulky rigid plastics for quite awhile, as there is demand for this material. With more material being generated, the difficulty comes in trying to define exactly what to call these bales of mixed plastic types and products. As a result, the Association of Post-consumer Plastic Recyclers (APR) has taken on the task of defining bale specifications for these additional plastic bales being generated at MRFs.

APR has completed model bale specifications for "Tubs and Lids" bales and "Bulky Rigid" bales. (These specification documents are available for review in Appendix B). Along with developing bale specifications for the remaining bale types, the APR has also created a task force to identify and develop markets for these valuable recycled materials. Task force members include generators/collectors (the MRF operators); recyclers and reclaimers; brand name companies; virgin resin producers and public policy makers. Although currently most mixed plastics bales are exported (with the exception of Bulky Rigid bales), through work of the APR task force and its member companies, new domestic markets are emerging. As we see more communities move to single-stream recycling collection, more plastics will be generated. Consumers want to recycle more plastic and collecting more plastics provides a needed and critical supply to feed the emerging plastic recycling market.

The seven (7) types of mixed resin bales are described in the following chart.

Bale Name & Origin	Definition
All Rigid Plastic From MRFs that combine all bottles, containers and bulky plastics into a single bale	Bottles and caps, Non-bottle rigid containers (includes cups, trays, boxes, clamshells, tubs, pots, deli containers, carton, blister), Bulky rigid plastic (includes carts, crates, buckets, baskets, toys, lawn furniture)
Bottles and Containers From MRFs that mix plastic bottles and containers together, but do not have—or separately bale—bulky rigid plastics	Bottles and caps, Non-bottle rigid containers (includes cups, trays, boxes, clamshells, tubs, pots, deli containers, carton, blister)
Pre-picked From MRFs that pull PET and HDPE bottles and bale all remaining rigid plastics	Non-bottle rigid containers (includes cups, trays, boxes, clamshells, tubs, pots, deli containers, carton, blister) Bulky rigid plastic (includes carts, crates, buckets, baskets, toys, lawn furniture) Very few bottles
Household Containers From MRFs that pull PET and HDPE bottles and bale all remaining plastic bottles and containers together, but do not have—or separately bale—bulky rigid plastic	Non-bottle rigid containers (includes cups, trays, boxes, clamshells, tubs, pots, deli containers, carton, blister) Some bottles (primarily non-PET & HDPE) No bulky rigid plastic
Tubs and Lids From MRFs that service Tubs and Lids programs	Non-bottle rigid household containers including buckets - predominantly PP and PE Bale Specifications available [online] http://www.plasticsrecycling.org/technical-resources/model-bale-specification/tubs-and-lids
Bulky Rigid From MRFs that pull large plastic items, usually at the front end	Bulky rigid plastic (includes carts, crates, buckets, baskets, toys, lawn furniture) predominantly PE and PP Bale Specifications available [online] http://www.plasticsrecycling.org/technical-resources/model-bale-specification/bulky-rigids
Olefin Bales From MRFs that pull PET and HDPE bottles, then mixed olefin plastic	PE and PP bottles, PE and PP non-bottle containers, and PE and PP bulky rigid plastic

The 2009 National Postconsumer Recycling Report on Non-Bottle Rigid Plastics can be found at http://plastics.americanchemistry.com/09-Post-Consumer-%20Non-Bottle-Rigid-Plastic-Recycling-Report.

Film, Bag and Wrap recycling

Moore Recycling Associates, with funding from the Plastics Division of the American Chemistry Council, has tracked film, bag and wrap recycling in the US for the past 5 years. As has been the trend in past years, the 2009 National Post-consumer Recycled Plastic Bag and Film Report stated that the majority of film material collected for recycling was sold to the export market. Plastic bag and film recovery has increased by 31% since 2005—a direct result of increased film recovery programs as well as general increased awareness of the value of clean high quality post-consumer film.

Plastic film is classified into 5 basic categories for recycling:

Commercial Film - Clear, clean PE film including stretch wrap and poly bags

Mixed Film – Mixed color clean PE film including grocery bags

Curbside Film – mixed PE film generated at MRFs

Dirty Ag Film – From the ground –up to 50% contamination (PE film)

Clean Ag Film - Dry and from uses that do not touch the ground up to 10% contamination (PE film)

The export market dominates the end market options for collected film. Although there are a few companies practicing bag-to-bag recycling, on the domestic front, plastic lumber manufacturers dominate the end use market for films.

There are more than 12,000 retail stores with plastics bag collection programs, located in every state in the US. In addition, there are some government and non-profit run film and bag drop-off programs, but the majority of programs are retailer-based programs. These programs are usually anchored by a major grocery or retail chain stores already recovering plastic film scrap.
In Maine, there is a program promoting the use of reusable shopping bags and increasing the recycling of 'first use' plastic bags. The effort is called 'Got Your Bags, Maine?' and is sponsored by the Maine Grocers Association, the Maine Merchants Association, the Natural Resources Council of Maine with support from the Maine State Planning Office. Retailers in Maine are

required by law to provide for the recycling of plastic shopping bags with a container near their front door and having the collected bags recycled. The Got Your Bags, Maine program uses a logo known as 'Sally', to promote a store's participation. For more information and to view the program's toolkit, visit http://www.facebook.com/gotyourbagsmaine

Although consumers are becoming more aware of plastics bag recycling opportunities, they are less likely to be aware of the additional plastic films that can also be recycled including newspaper bags, the wrap around toilet paper, the wrap around flats of water or canned cat food, the outer wrap of bread bags, etc. (A poster describing acceptable films in the ACC film supported programs is available in Appendix C.). **Please check your current recycling site for acceptable films before depositing mixed film materials**.

Consumers are also remembering to use reusable bags. Both actions—remembering to bring a reusable bag and remembering to bring film, bags and wrap for recycling—are similar behavior changes being promoted in many retail programs across the U.S.

Plastic film recovery is expected to increase as more businesses identify ways to efficiently recover scrap film and consumers become aware of the many other film, bags and wraps acceptable for recycling.

There are case studies of model plastic bag and film recycling programs and other resources (including signs and the poster above) for anyone interested in developing a plastic bag recycling program on www.plasticbagrecycling.org. The 2009 National Post-consumer Plastic Bag and Film Report can be found at http://plastics.americanchemistry.com/Bag-and-Film-Report.

Export

In past years, the export market, especially China, has been a major player in purchasing recycled plastic bales from the US—especially from the west coast. They were able to offer a higher price for the material due to demand for the raw material and the fact that labor was relatively cheap. As China's economy grows, China's consumers are generating their own scrap material

and the labor force is gaining strength. This additional 'in-country' growth may have an impact on future export options for the United States. As a result, China is not showing the same ability to continue to offer a higher price for material. Stiffer import restrictions in China have also contributed to softer export pricing, further strengthening the domestic purchasing capabilities. If the export market does decline, the US reclaimers could use all the material that is currently being exported. As stated earlier in this report, domestic reclaimers are operating below capacity and are constantly looking for ways to recover more plastic bottles, specifically HDPE and PET. The only stumbling block to expanded plastics recycling in the US is securing adequate supply.

Recent market dynamics show that US east-coast reclaimers are purchasing material from the US west-coast suppliers. Projections are that for some materials, the domestic market will be the price leaders and not the export market as has been the trend in the past several years. It remains to be seen if this shift will have any effect on the quality of baled material generated from MRFs in the US.

An article in the November 2010 issue of Resource Recycling magazine is a perspective on PET recycling and PET exports. Authors, Mike Schedler and Kate Eagles point out the connection between exporting plastics to domestic job loss, energy loss and the loss of economic benefits that come from the plastics recycling industry in the US. The full article is available at http://www.napcor.com/. On the right column, news and events, click on January 2011.

Single Stream Recycling

Single stream recycling is a collection strategy for permitting the pick-up of recyclables all mixed together (containers and papers, metal and glass and plastics) which can reduce the cost of providing the collection service. The processing of the mixed recyclables then requires a facility with equipment and staff that are able to sort the mixed stream of materials into various components, such as newsprint, glass, plastics and such, for the marketing of the materials to manufacturers and reclaimers.

Along with single stream recycling comes the desire and ability to recycle more plastics. Although the general observations are that plastic bale quality has declined with the move to single stream recycling, it does not appear to have significantly affected the marketability of plastic bales. This could be a result of the lack of bale quality feedback from the export market as well as a strong domestic demand. As stated earlier, domestic HDPE and PET reclaimers have seen a decrease in bale yield, likely as a result of single stream recycling, and the desire to recycle more plastics.

The lower quality of baled plastic is not directly due to single stream in and of itself. The problem is in the inefficiencies of MRF operations, such as... public education about what materials are acceptable, too few pickers on sort lines and confusion about exactly what should be in each bale. As for technology improvements, if there is a demand, technology improves with time. MRFs are looking at improving efficiencies and new automatic sorting technologies are continually coming on the market. The new mixed plastic bale terminology and specifications should help in defining how to sort for the best marketability options. Without these specifications to assist MRF operators in generating high quality resin bales, MRFs are often unable to tap into the domestic market and are left with exporting low-quality mixed resin bales to China.

Surveys show that single stream recycling is expanding across the country and is not going away. When communities review all of the various components and systems of their recycling program options, the improved economics of collection with single stream recycling may outweigh other considerations, such as quality of materials prepared for marketing. This is especially true when there is a ready export market for lower-quality baled materials.

Maine Beverage Container Redemption Program

Maine has had an expanded bottle bill in effect since 1990. The bottle bill includes deposits on all beverage containers including wine, liquor, beer, all water beverages, juice, soda and sports drinks. The bill also covers all sizes of glass, aluminum, and plastics containers, up to four (4) liters. Dairy products and some ciders are not covered by the bottle bill in Maine.

When the bottle bill became law in Maine in the mid 1970's, most beverage containers were either metal or glass. Now, however, plastic beverage containers have a prominent position as a material for beverages. Early on, these containers were either PET or HDPE. Although this is still the case, there are numerous products now packaged in PET that are not covered under the bottle bill. Products now packaged in PET include soup, nut butters, and other food items, as well as personal toiletries, shampoos, liquid soap, cleaning products to name just a few. (Refer to Appendix A on Plastic Packaging Resins for more information).

States with bottle bills have higher recovery rates for beverage containers and the material is cleaner than material collected through other methods. The Maine Legislature recently rejected a number of proposals that would have resulted in significant changes to the current bottle bill. Some of the changes suggested included; targeting fewer containers; limiting the size of containers that require deposit; and, eliminating the bottle bill altogether. Because so many beverages are now packaged in PET plastic, any or all of these changes could pose potential problems for recyclers in Maine and reclaimers throughout the US.

Because the majority of PET was (and remains) beverage containers at the inception of the Maine bottle bill, many communities do not collect PET because most of it is recovered through the deposit law. In addition, handling issues related to PET recycling such as baling discouraged early participation in the collection of PET. Most Maine municipal or residential recycling programs accept HDPE for recycling. This includes dairy bottles (natural HDPE), detergent bottles, many cleaning product bottles and some personal toiletry bottles (pigmented HDPE). Some municipal programs also accept PET but this is not always the case. There are ready markets for HDPE bottles and communities find it easy to assimilate enough material to meet shipping requirements.

Even though more and more products are being packaged in PET, and therefore appearing in the municipal waste stream, not all Maine communities have access to PET recycling in their municipal program. In addition, without including beverage bottles it is difficult to amass enough material to meet shipping volume requirements. The cost of adding another relatively low volume (due to most PET bottles being pulled through the bottle bill) recyclable material to an already stressed municipal recycling

system—especially a material that would need to be handled separately in order to be marketable—has prohibited many community recycling programs from adding PET to the materials they collect. In these instances, if Maine drops PET from a deposit, the PET bottles might end up as litter or being thrown away in landfills and/or waste to energy plants. On the other hand, an increase of PET in the residential waste stream, the high value of PET and/or the opportunity to move to single stream collection might encourage communities to include PET in their recycling programs.

The US demand for recovered PET and HDPE bottles currently outweighs the available supply. Industry representatives are working to educate communities, consumers, and sporting and special events venues on the value of this resource, the importance of recovering more plastic bottles, and the need to keep the bottles in the US to feed the growing PET and HDPE reclamation industry.

Looking Ahead

Plastics recycling accessibility

The Plastics Division of the American Chemistry Council sponsored a study to determine what types of plastics recycling programs are occurring around the US. The purpose of the study was to determine the types of rigid plastics collected curbside or at municipal drop-offs around the country and to determine what percentage of the population has access to plastics recycling. In addition the study looked at public education methodologies to describe acceptable materials and identify any new trends given that many programs collect plastics beyond #1 and #2 bottles.

The study concludes that plastics recycling is widespread yet recovery rates for plastic bottles remains below 30%, showing room for improvement and the need for clear and universal language to educate the public on available plastics recycling programs and items acceptable for plastics recycling. The full report, “Plastic Recycling Collection: National Reach Study,” is available at http://plastics.americanchemistry.com/National-Reach-Study.

Single Stream Recycling Expansion

The trend toward single stream recycling continues to climb as more communities look for ways to increase collection efficiencies. Maine has a single stream facility, ecomaine, located in Portland, ME. As with plastics recycling plants, single stream processing facilities are dependent on critical volume to be economically sustainable. Given the size of Maine and the distance from the northern and eastern communities to Portland, it does not seem economically feasible that all communities would benefit by going single stream as shipping commingled loose material to Portland would either be cost prohibitive or negate the cost savings of commingled collection.

Putting a second single stream facility in the northern part of Maine might not be the best answer either given the lack of population density necessary to provide the volume of material would necessary to make the venture successful. Some companies are looking at the feasibility of locating transfer stations or consolidation facilities in Maine for single stream material. At the time of this report they are in the planning stage. Once again, critical volume will drive this business development. Communities located in close proximity to a single stream facility tend to reap the most benefit from switching from separated-material collection methodologies to single stream due to the high cost of transportation. Each community must research their options and associated costs since each recycling programs is unique to itself.

New Technologies

As stated earlier, the technologies associated with plastic recycling are always improving as handlers, reclaimers and product manufacturers strive for business sustainability and economic growth.

One new technology addresses densifying plastic bottles recovered through deposit programs to eliminate the high cost of transportation to market. The Haul-All Twister 20 is specifically designed to permanently compress PET & HDPE post consumer bottles, with compression rates from 4:1 to 8:1. Using rotary auger compaction technology and a hydraulically controlled pressurizing end gate system, the TW20 unit can be set to achieve any

consistent compression rate factor, without building product together, to facilitate automated sorting. Fourteen units were installed in California at deposit buyback centers using a grant from the CA Department of Conservation. They found that the units:

1. Reduced labor costs associated with material handling;
2. Removed fraud potential by early product cancellation;
3. Significantly increased efficiency by maximizing transportation payloads from redemption centers to processors;
4. Improved baling speed and capacity at larger processing centers and for export;
5. Increased profit by ensuring full weight export loads;
6. Eliminated baling and de-baling process for in-state users; and
7. Significantly reduced carbon footprint by maximizing efficiencies in material transportation.

More information on the Twister 20 is available on line at http://www.nexgenmunicipal.com/en_twister_20.asp

Summary

The plastics recycling industry in the US is strong and growing, and demand for recycled plastics far outweighs supply. Reclaimers of all plastic bottle types are in need of more material to maximize their processing capability and provide product to the demanding end use markets. Plastic film recovery continues to grow as businesses recognize the value of plastic film scrap and more programs come on line to recover plastic films.

Single stream recycling opens more opportunities to recover more plastics from the municipal waste stream creating more reclamation opportunities for more types of recovered plastics. There are also new reclaimers with sorting and processing technologies that allow mixing of different resins for new end product applications.

Public education and outreach must be on-going to keep community residents informed of existing and new plastic recycling opportunities and what plastic materials are acceptable for recycling. Industry, public

recycling officials and consumers need to work together to identify ways to recover more plastic bottles that are discarded away from home be it traveling, at work or at special venues.

Plastics recycling opportunities continue to grow and evolve. To bring plastic recycling full circle, manufacturers should be attuned to using recycled plastic feedstock in applicable products and consumers should look for products that are made from or packaged in recycled plastic.

Resources for this report are listed in the Appendix, page 17.

Appendices

Resources

Plastic Packaging Resins
http://plastics.americanchemistry.com/Education-Resources/Plastics-101/Plastics-Resin-Codes-PDF.pdf
2009 United States Post-Consumer Plastics Bottle Recycling Reort
http://plastics.americanchemistry.com/09-Post-Consumer-Plastics-Bottle-Recycling-Rpt
Association of Post-Consumer Plastic Recyclers/Bale Specifications
http://www.plasticsrecycling.org/technical-resources/model-bale-specification
2009 National Post-Consumer Recycling Report on Non-Bottle Rigid Plastics
http://plastics.americanchemistry.com/09-Post-Consumer-%20Non-Bottle-Rigid-Plastic-Recycling-Report
2009 National Post-consumer Plastic Bag and Film report
http://plastics.americanchemistry.com/Bag-and-Film-Report
Ship in a Bottle
http://www.napcor.com/pdf/PlasticsRecyUpdate11-10.pdf
Plastic Recycling Collection: National Reach Study
http://plastics.americanchemistry.com/National-Reach-Study

Plastic Packaging Resins

American Chemistry Council

Plastic Packaging Resins

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
1 PET	**Polyethylene Terephthalate (PET, PETE).** PET is clear, tough, and has good gas and moisture barrier properties. This resin is commonly used in beverage bottles and many injection-molded consumer product containers. Cleaned, recycled PET flakes and pellets are in great demand for spinning fiber for carpet yarns, producing fiberfill and geo-textiles. Nickname: Polyester.	• Clear and optically smooth surfaces for oriented films and bottles • Excellent barrier to oxygen, water, and carbon dioxide • High impact capability and shatter resistance • Excellent resistance to most solvents • Capability for hot-filling	Plastic bottles for soft drinks, water, juice, sports drinks, beer, mouthwash, catsup and salad dressing. Food jars for peanut butter, jelly, jam and pickles. Ovenable film and microwavable food trays. In addition to packaging, PET's major uses are textiles, monofilament, carpet, strapping, films, and engineering moldings.	Fiber for carpet, fleece jackets, comforter fill, and tote bags. Containers for food, beverages (bottles), and non-food items. Film and sheet. Strapping.
2 HDPE	**High Density Polyethylene (HDPE).** HDPE is used to make many types of bottles. Unpigmented bottles are translucent, have good barrier properties and stiffness, and are well suited to packaging products with a short shelf life such as milk. Because HDPE has good chemical resistance, it is used for packaging many household and industrial chemicals such as detergents and bleach. Pigmented HDPE bottles have better stress crack resistance than unpigmented HDPE.	• Excellent resistance to most solvents • Higher tensile strength compared to other forms of polyethylene • Relatively stiff material with useful temperature capabilities	Bottles for milk, water, juice, cosmetics, shampoo, dish and laundry detergents, and household cleaners. Bags for groceries and retail purchases. Cereal box liners. Reusable shipping containers. In addition to packaging, HDPE's major uses are in injection molding applications, extruded pipe and conduit, plastic wood composites, and wire and cable covering.	Bottles for non-food items, such as shampoo, conditioner, liquid laundry detergent, household cleaners, motor oil and antifreeze. Plastic lumber for outdoor decking, fencing and picnic tables. Pipe, floor tiles, buckets, crates, flower pots, garden edging, film and sheet, and recycling bins.

Plastic Packaging Resins

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
	**Polyvinyl Chloride (PVC, Vinyl).** In addition to its stable physical properties, PVC has good chemical resistance, weatherability, flow characteristics and stable electrical properties. The diverse slate of vinyl products can be broadly divided into rigid and flexible materials.	• High impact strength, brilliant clarity, excellent processing performance • Resistance to grease, oil and chemicals	Rigid packaging applications include blister packs and clamshells. Flexible packaging uses include bags for bedding and medical, shrink wrap, deli and meet wrap and tamper resistance. In addition to packaging, PVC's major uses are rigid applications such as pipe, siding, window frames, fencing, decking and railing. Flexible applications include medical products such as blood bags and medical tubing, wire and cable insulation, carpet backing, and flooring.	Pipe, decking, fencing, paneling, gutters, carpet backing, floor tiles and mats, resilient flooring, mud flaps, cassette trays, electrical boxes, cables, traffic cones, garden hose, and mobile home skirting. Packaging, film and sheet, and loose-leaf binders.
	**Low Density Polyethylene (LDPE).** LDPE is used predominately in film applications due to its toughness, flexibility and relative transparency, making it popular for use in applications where heat sealing is necessary. LDPE also is used to manufacture some flexible lids and bottles as well as in wire and cable applications. Includes Linear Low Density Polyethylene (LLDPE).	• Excellent resistance to acids, bases and vegetable oils • Toughness, flexibility and relative transparency (good combination of properties for packaging applications requiring heat-sealing)	Bags for dry cleaning, newspapers, bread, frozen foods, fresh produce, and household garbage. Shrink wrap and stretch film. Coatings for paper milk cartons and hot and cold beverage cups. Container lids. Toys. Squeezable bottles (e.g., honey and mustard). In addition to packaging, LDPE's major uses are in injection molding applications, adhesives and sealants, and wire and cable coverings.	Shipping envelopes, garbage can liners, floor tile, paneling, furniture, film and sheet, compost bins, trash cans, landscape timber, and outdoor lumber.
	**Polypropylene (PP).** PP has good chemical resistance, is strong, and has a high melting point making it good for hot-fill liquids. This resin is found in flexible and rigid packaging, fibers, and large molded parts for automotive and consumer products.	• Excellent optical clarity in biaxially oriented films and stretch blow molded containers • Low moisture vapor transmission • Inertness toward	Containers for yogurt, margarine, takeout meals, and deli foods. Medicine bottles. Bottle caps and closures. Bottles for catsup and syrup. In addition to packaging, PP's major uses are in fibers, appliances and	Automobile applications, such as battery cases, signal lights, battery cables, brooms and brushes, ice scrapers, oil funnels, and bicycle racks. Garden rakes, storage bins, shipping pallets, sheeting, trays.

Plastic Packaging Resins

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
		acids, alkalis and most solvents	consumer products, including durable applications such as automotive and carpeting.	
	**Polystyrene (PS).** PS is a versatile plastic that can be rigid or foamed. General purpose polystyrene is clear, hard and brittle. It has a relatively low melting point. Typical applications include protective packaging, foodservice packaging, bottles, and food containers. PS is often combined with rubber to make high impact polystyrene (HIPS) which is used for packaging and durable applications requiring toughness, but not clarity.	• Excellent moisture barrier for short shelf life products • Excellent optical clarity in general purpose form • Significant stiffness in both foamed and rigid forms. • Low density and high stiffness in foamed applications • Low thermal conductivity and excellent insulation properties in foamed form	Food service items, such as cups, plates, bowls, cutlery, hinged takeout containers (clamshells), meat and poultry trays, and rigid food containers (e.g., yogurt). These items may be made with foamed or non-foamed PS. Protective foam packaging for furniture, electronics and other delicate items. Packing peanuts, known as "loose fill." Compact disc cases and aspirin bottles. In addition to packaging, PS's major uses are in agricultural trays, electronic housings, cable spools, building insulation, video cassette cartridges, coat hangers, and medical products and toys.	Thermal insulation, thermometers, light switch plates, vents, desk trays, rulers, and license plate frames. Cameras or video cassette casings. Foamed foodservice applications, such as egg shell cartons. Plastic mouldings (i.e., wood replacement products). Expandable polystyrene (EPS) foam protective packaging.
	**Other.** Use of this code indicates that a package is made with a resin other than the six listed above, or is made of more than one resin and used in a multi-layer combination.	Dependent on resin or combination of resins	Three- and five-gallon reusable water bottles, some citrus juice and catsup bottles. Oven-baking bags, barrier layers, and custom packaging.	Bottles and plastic lumber applications.

***Recycling may not be available in all areas. Check to see if plastics recycling is available in your community.**

Appendix B
Bale Specifications

The Association of Postconsumer Plastic Recyclers

Model Bale Specifications: Bulky Rigids

This model, as approved by APR, is not meant to replace the specifications of individual buyers, many of whom may have different 'allowables' in terms of contents and bale sizes. Rather, this model is meant to provide a benchmark to suppliers, indicating that Bulky Polyolefin Rigids bales produced to this model will be accepted by APR members.

POST-CONSUMER BULKY RIGIDS BALE MODEL SPECIFICATION

Any large rigid plastic bulky item removed in an initial positive sort from a curbside, drop-off, or other public or private recycling collection programs. Typical bulky rigid items are carts, crates, buckets, baskets, toys, lawn furniture, etc. These items are typically manufactured from HDPE, PP or LDPE, which are #2, #5 and #4 respectively in the Society of the Plastics Industry's (or ASTM D 7611) resin codes.

Metal as typically found in toys or bucket handles should be removed when possible. Plastic items from construction or demolition should not be included in bulky rigid bales. Electronic scrap (computer housings, printer housing, etc.) should also not be included. All items should be free of contents or free flowing liquids and organic residues. Post-consumer is defined as "used for its intended purpose and otherwise directed to disposal".

ACCEPTABLE LEVELS OF CONTAMINANTS:
The following list of contaminants should not exceed a total of 10% by weight:

- Any plastic items or packaging, including PET (#1), PVC (#3), PS (#6), Other (#7) (4% maximum allowed),
- Metal (2% maximum allowed),
- Paper/cardboard (2% maximum allowed),
- Liquid or other residues (2% maximum allowed).

THE TOTAL MAXIMUM LEVEL OF CONTAMINATION SHOULD NOT EXCEED 10% BY WEIGHT

THE FOLLOWING CONTAMINANTS ARE NOT ALLOWED AT ANY LEVEL:

- Any plastic bags, sheets, or film made from HDPE (#2), LDPE (#4), or any other plastic resin
- Wood
- Plastic siding/ Construction & Demolition waste
- Glass
- Electronics scrap
- Paint
- Toys and other items with circuit boards or battery packs
- Oils and Grease

The Association of Postconsumer Plastic Recyclers

- Rocks, stones, mud, dirt
- Medical and hazardous waste
- Products with degradable additives

In addition, any plastic that previously contained any hazardous or potentially hazardous material, including but not limited to chemical agricultural products, pesticides, herbicides, medical products (drugs, IV solutions, syringes/hypodermic needles, and sharps), flammable, corrosive or reactive liquids, grease and solvents are expressly prohibited. This rule applies even if the aforementioned material was not the original contents of the container. (Suppliers must certify that the bales they supply do not contain the above prohibited materials).

Many purchasers will reject an entire load if any of the above materials are found and will return them at the supplier's expense.

Bale Size	Approximately, 30"x42"x 48" or 30"x48"x 60", i.e. Bale Sizes should allow a minimum of 35,000 pounds to be shipped on 48 foot trailer, which is an industry standard. Individual companies may apply price deductions for shipments that do not meet minimum weight requirements.
Bale Density	15-20 lbs/ft^3
Bale Wire	Bales should be held together with 10-12 gauge, noncorrosive galvanized metal wire (or other non-corrosive strapping), with all bale wires wrapped in one direction (no crisscrossing or double-strapping). A minimum number of bale wires should be used to maintain bale integrity. This number will vary with bale size and density.
Bale Tare Weight	A tare weight of 8 pounds per bale will be taken from the gross weight.
Bale Integrity	Bale integrity must be maintained throughout loading, shipping, unloading and storage.
Minimum Shipping Weight	35,000 lbs.
Storage	Bales should be stored indoors or covered outdoors. Material must not be stored outdoors uncovered for a period exceeding four (4) weeks to prevent UV degradation from direct sunlight and moisture contamination

The Association of Postconsumer Plastic Recyclers

Model Bale Specifications: Tubs & Lids

This model, as approved by APR, is not meant to replace the specifications of individual buyers, many of whom may have different 'allowables' in terms of contents and bale sizes. Rather, this model is meant to provide a benchmark to suppliers, indicating that Tubs & Lids bales produced to this model will be accepted by APR members.

POST-CONSUMER TUBS AND LIDS BALE MODEL SPECIFICATION

Any whole, injection-molded (occasionally formed from other processes) container containing polypropylene with the ASTM D7611 or Society of the Plastics Industry's "#5, PP" resin identification code **and/or** polyethylene with either the (ASTM D7611) "#2, HDPE" **and/or** "#4, LDPE" resin identification codes, generated from a positive sort of a curbside, drop-off, or other public or private recycling collection programs.

Tubs are defined as containers that have a neck or mouth that is similar in size to the base. Lids are defined as caps for tubs that have a fastening feature other than threads. All tubs and lids should be free of contents or free flowing liquids, rinsed, and dried. Post-consumer is defined as "used for its intended purpose and otherwise directed to disposal".

ACCEPTABLE LEVELS OF CONTAMINANTS:
The following list of contaminants should not exceed a total of 10% by weight:

- Bottles containing PET (#1) (1% maximum allowed)
- Injection-molded HDPE (#2) pails, buckets, milk jugs or bottle materials (6% maximum allowed)
- Any plastic containers or packaging including PET (#1), PVC (#3), PS (#6), Other (#7) (2% maximum allowed)
- Paper/cardboard (2% maximum allowed)
- Liquid or other residues (2% maximum allowed).

THE TOTAL MAXIMUM LEVEL OF CONTAMINATION SHOULD NOT EXCEED 10% BY WEIGHT

THE FOLLOWING CONTAMINANTS ARE NOT ALLOWED AT ANY LEVEL:

- Any plastic bags, sheets, or film made from HDPE (#2), LDPE (#4), or any other plastic resin
- Wood
- Metal
- Glass
- Electronics scrap
- Paint
- Toys and other items with circuit boards or battery packs

The Association of Postconsumer Plastic Recyclers

- Oils and Grease
- Rocks, stones, mud, dirt
- Medical and hazardous waste
- Products with degradable additives

In addition, any plastic container that previously contained any hazardous or potentially hazardous material, including but not limited to chemical agricultural products, pesticides, herbicides, medical products (drugs, IV solutions, syringes/hypodermic needles, and sharps), flammable, corrosive or reactive liquids, grease and solvents are expressly prohibited. This rule applies even if the aforementioned material was not the original contents of the container. Suppliers must certify that the bales they supply do not contain the above prohibited materials.

Many purchasers will reject an entire load if any of the above materials are found and will return them at the supplier's expense.

Bale Size	Approximately 30"x42"x 48" or 30"x48"x 60", For example, bale sizes should allow a minimum of 35,000 pounds to be shipped on 48 foot trailer, which is an industry standard. Individual companies may apply price deductions for shipments that do not meet minimum weight requirements.
Bale Density	15-20 lbs/ft^3
Bale Wire	Bales should be held together with 10-12 gauge, noncorrosive galvanized metal wire (or other non-corrosive strapping), with all bale wires wrapped in one direction (no crisscrossing or double-strapping). A minimum number of bale wires should be used to maintain bale integrity. This number will vary with bale size and density.
Bale Tare Weight	A tare weight of 8 pounds per bale will be taken from the gross weight.
Bale Integrity	Bale integrity must be maintained throughout loading, shipping, unloading and storage.
Minimum Shipping Weight	35,000 lbs.
Storage	Bales should be stored indoors or covered outdoors. Material must not be stored outdoors uncovered for a period exceeding four (4) weeks to prevent UV degradation from direct sunlight and moisture contamination

Appendix C


RECYCLE
CLEAN, DRY, EMPTY
PLASTIC BAGS
& FILM
PACKAGING
AT THIS STORE
RECYCLE PLASTIC BAGS HERE
Baby Diapers
Bath Tissue
1000 Sheets
Napkins
ITALIAN BREAD
PAPER TOWELS
new bags and packaging
composite lumber & construction materials
Look for clearly marked recycling bins at the stores entrances and exits
Recycling of plastics bags and film may not be available everywhere. Please check for recycling facilities in your area.